A New *Triraphis* (Poaceae: Eragrostideae) from Brazil: First Record of a Native Species in the New World

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ABSTRACT. *Triraphis devia* Filgueiras & Zuloaga from central Brazil is described as a new species, illustrated, and compared with morphologically similar species in the genus. Anatomical and ecological data are presented together with a biogeographical discussion. A tentative key to all the species of *Triraphis* is provided. This is the first record of a native *Triraphis* in Brazil and in South America.

During field excursions undertaken by the senior author and collaborators for the Biogeography of the Cerrado Biome project (Felfili et al., 1994) several grass species were collected that could not be identified. One of these grasses is herein described as a new species of *Triraphis* R. Brown.

Triraphis comprises seven species, six of which occur in Africa and one in Australia, always in savanna habitats, often in sandy or stony soils (Clayton & Renvoize, 1986; Watson & Dallwitz, 1992).

Triraphis devia Filgueiras & Zuloaga, sp. nov. TYPE: Brazil. Goiás: Chapada dos Veadeiros, município de Alto Paraíso, ca. 17 km da cidade, em direção a Colinas de Goiás, 14°09′30″S, 47°39′54″W, ca. 1200 m, ereto, cerca 60 cm de altura, campo limpo, 23 Nov. 1994, *T. S. Filgueiras & D. Alvarenga 3168* (holotype, IBGE; isotypes, F, ICN, K, MEXU, MO, SI, SP, US). Figures 1, 2.

T. andropogonoidi (Steudel) E. Phillips ex Africa similis autem culmis 12–49 cm longis, laminis 1.8–11.2 cm longis et 1.2–2.8 cm latis, panicula 2–6 cm longa, spiculis 4–8 flosculis absimilis.

Densely caespitose perennials. Rhizomes small, knotty. Culms 12–49 cm tall, erect, cylindrical, unbranched in the vegetative portion, delicate, fragile, with 1–2 elongated internodes; internodes 6.5–27.5 cm long, solid, filled with pith, glabrous, striate, stramineous to purplish, nodes darkish, glabrous. Leaves mostly basal, a few cauline; basal leaves strongly imbricate; basal sheaths 3.5–5.5 cm long, strongly keeled, glabrous, both margins hyaline, glabrous; cauline sheaths 3.5–5 cm long, keeled to round at the back, striate, margins hyaline, glabrous to sparsely pilose toward the apex; ligule a dense fringe of hairs, the hairs ca. 0.5 mm long, pale; the ligular hairs longer and denser at the extremities of the ligule; collar undifferentiated; auricles not present; blade 1.8–11.2 cm long and 1.2–2.8 mm wide, keeled to flat, linear, glabrous on both surfaces or with a few scattered hairs, strongly striate, surface rough, margins denticulate, apex naviculate to subnaviculate, the central nerve occasionally projected beyond the blade into an awn-like structure. Inflorescence an open, terminal panicle, 2–6 cm long and 1.6–4 cm wide (inclusive of awns), with 3–7 spikelets. Pedicels 5–18 mm long, scabrid. Spikelets 6–12 mm long and 5–9 mm wide (inclusive of awns), solitary or paired, laterally compressed, dark to purplish, 4–8-flowered, the apical floret reduced to a sterile lemma; glumes 2, persistent on the pedicel; lower glume 4–4.5 mm long, 1-nerved, rough along the nerve, apex acute, mucronate or aristate; mucro or awn 0.5–2.5 mm long; upper glume 4–4.5 mm long, 1-nerved, thinner than the lower glume, the apex 2-notched, the central nerve projected beyond the body of the glume into a straight mucro or awn, the mucro or awn 0.5–1.5 mm long; rachilla 0.5–0.8 mm long, well developed between the florets, pilose at the base; lemma 4–4.3 mm long, pilose at the base, 3-nerved, with 3 awns, two lateral and one terminal; lateral awns 4–5 mm long, originating from the lateral nerves, retrorsely barbed, straight, divergent; central nerve projecting into a straight awn, the awn 3.8–4.2 mm long, retrorsely barbed; apex of lemma deeply 2-notched, the lateral expanses acute to irregularly eroded at the apex; palea 4–4.5 mm long, 0.8–1.1 mm wide, strongly 2-keeled, hyaline, apex 2-notched; lodicules ca. ½ as long as the ovary, 2, fleshy, glabrous; ovary obconic, stipitate, pale; styles 3; lateral styles 0.5–0.8 mm long; the central

Figure 1. *Triraphis devia* Filgueiras & Zuloaga. —A. Habit. —B. Detail of apex of the blade. —C. Portion of the leaf in the ligular area. —D. Spikelet, lateral view. —E. Lower glume, dorsal view. —F. Upper glume, dorsal view. —G. Lemma, dorsal view. —H. Lemma and palea, ventral view. —I. Lemma, ventral view. —J. Palea with lodicules, ovary, and stamens. K, L. Caryopsis. —K. Embryo view. —L. Hilum view. (*Filgueiras & Alvarenga 3168.*)

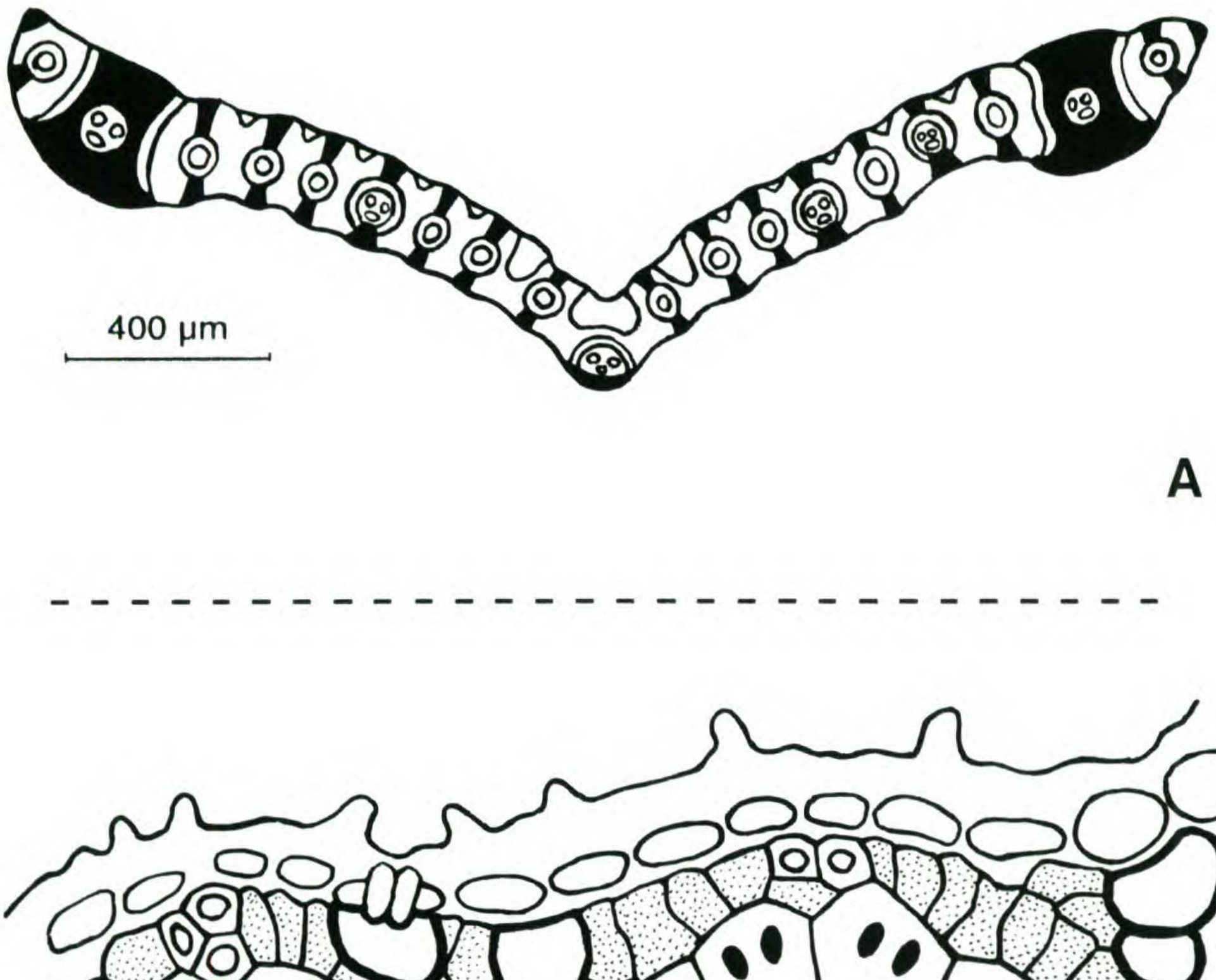

Figure 2. Leaf blade anatomy of *Triraphis devia*. —A. Blade outline showing V-shaped blade, with the central median bundle structurally distinguishable from the lateral first-order bundles; sclerenchyma conspicuous and associated with 1'vbs toward the margins. —B. Detail of radiate chlorenchyma, 1'vb and 2'vb with specialized chloroplasts in the outer bundle sheath. (*Filgueiras & Alvarenga 3168.*)

style 0.1–0.5 mm long; stigmas 2, at the apex of the lateral styles, purple; stamens 3, filament minute, pale, anthers 1.8–2 mm long, yellowish to tan. Apical floret reduced to a sterile lemma, occasionally the sterile lemma containing a minute, rudimentary sterile lemma inside. Caryopsis 1.8–3 mm long, ellipsoid, tan, with the 3 persistent stylar bases; embryo ca. ½ as long as the fruit; hilum ¼–⅓ as long as the caryopsis, dark, punctate-oblong, basal.

Paratypes. BRAZIL **Goiás:** Mun. Alto Paraíso, Parque Nacional Chapada dos Veadeiros, campo limpo, 28 Sep. 1995, *T. S. Filgueiras & F. C. A. Oliveira 3282* (B, BM, IBGE, P); Chapada dos Veadeiros, 17 km de Alto Paraíso/Colinas, Erva ca. 0.40 m de altura, campo limpo arenoso, 23 Nov. 1994, *M. Aparecida da Silva & F. C. A. Oliveira 2382* (IBGE, SP).

Leaf Anatomy

The standardized terminology of Ellis (1976, 1979) was used to describe the anatomical structure of the leaf blades. The following abbreviations are used in the anatomical description: vbs: vascular bundles; 1'vb(s): first-order vascular bundle(s); 2'vb(s): second-order vascular bundle(s); obs: outer bundle sheaths.

LEAF BLADE IN TRANSVERSE SECTION (FIG. 2)

Outline: V-shaped; two halves of lamina symmetrical about the median vascular bundle; leaf blade section includes between 18 and 20 vbs; adaxial and abaxial surface without ribs and furrows. *Midrib*: a definite keel; median vascular bundle structurally distinguishable from other 1'vbs. *Vascular bundle arrangement*: 3 2'vbs between consecutive lateral 1'vbs; all vbs positioned at the same level. *Vascular bundle description*: 1'vbs elliptical to subcircular in outline, circular metaxylem vessels narrow with diameters less than half those of the obs cells; 2'vbs elliptical in outline, with phloem and xylem distinguishable. *Vascular bundle sheaths*: outer Kranz parenchyma sheath conspicuous, regular in outline, continuous in 2'vbs, interrupted in 1'vbs by sclerenchyma girders toward both surfaces or only toward the abaxial surface; specialized chloroplasts present, of centrifugal position (?); adaxial and abaxial bundle sheath extensions absent. Inner mestome sheath entire, of small cells with uniformly thickened walls.

Sclerenchyma: small, inconspicuous sclerenchyma strands associated with all vbs, both adaxially and abaxially, except toward the margins where they are conspicuous and associated with first-order vascular bundles.

Mesophyll: chlorenchyma radiate, interrupted toward both surfaces by sclerenchyma girders, compactly arranged with a few intercellular air spaces; chlorenchyma cells tabular; 2–3 chlorenchyma cells between consecutive vbs. Arm cells absent. Fusoid cells absent.

Adaxial epidermal cells: bulliform cells conspicuous and associated with the median vascular bundle, fan-shaped and covering ½–¾ the width of the transverse section; also in small groups in adaxial furrows and between the vascular bundles. Epidermal cells small, regular in size, the cuticle thick and continuous; papillae and prickles present. *Abaxial epidermal cells*: bulliform cells absent; epidermal cells small; papillae absent; hooks present.

Discussion

This new species shares the following generic characters with other taxa included in *Triraphis*: inflorescence an open panicle, with spikelets laterally compressed, several flowers per spikelet, lower and upper glume 1-nerved, shorter than the spikelet, lemmas with three awns, and a similar leaf anatomy and Kranz syndrome. *Triraphis andropogonoides*, the closest relative of *T. devia*, can be distinguished by being rhizomatous plants, with long creeping rhizomes, the culms 120 cm tall, the leaves 20–40 cm long, inflorescences 12–30 cm long, and spikelets 5–15-flowered.

The following is a tentative key to distinguish the species in *Triraphis* (based on Gibbs Russell et al., 1990):

1. Plants annual 2
1′. Plants perennial 3
2(1). Spikelets 2–4 mm long; anthers 0.2–0.4 mm . . . . . *T. pumilio* R. Brown
2′. Spikelets 6–10 mm long; anthers 1.2–2 mm . . . . . *T. purpurea* Hackel
3(1). Culms profusely branched . . . . . *T. ramosissima* Hackel
3′. Culms not branched 4
4(3). Panicle 2–6 cm long . . . . . *T. devia* Filgueiras & Zuloaga
4′. Panicle 12–40 cm long 5
5(4). Plants up to 60 cm tall; panicle contracted; spikelets 4 mm long . . . . . *T. mollis* R. Brown
5′. Plants up to 140 cm tall; panicle open; spikelets 6–11 mm long 6
6(5). Panicle sparse; central awn of lemma longer than the lemma . . . . . *T. schinzii* Hackel
6′. Panicle dense; central awn of lemma shorter than the lemma . . . . . *T. andropogonoides* (Steudel) E. Phillips

The arrangement of mesophyll tissue, together with the presence of specialized chloroplasts in the outer bundle sheath cells, indicates that this new species has a Kranz, PS (=XyMs+) anatomy (terminology of Hattersley & Watson, 1976). Also, two or three chlorenchymatous mesophyll cells are found between successive vascular bundles, which further indicates a C_4 anatomical organization (Hattersley & Watson, 1975). This agrees with the anatomy described for *Triraphis* (Watson & Dallwitz, 1992). The position of the specialized chloroplasts, in the outer bundle sheath, was difficult to ascertain due to the absence of fresh material to carry on the anatomical observations. It is noteworthy to mention the presence of conspicuous sclerenchyma tissue toward both margins, combined with the presence of well-developed bulliform cells toward the keel of the blade; consequently, it is possible to conclude that the blades can be easily folded under water stress conditions.

Two populations of *Triraphis devia* were located during field excursions, one inside the Parque Nacional Chapada dos Veadeiros and the other along an unpaved road, between the town of Alto Paraíso and the village of São Jorge. The latter population is obviously under great threat because the area is used as a native pasture. In addition, erosion is beginning to eliminate the vegetation along the unpaved road, including plants of this new species. The population inside the Parque is legally protected. In both cases, the plants grew in stony soil, apparently extremely poor in nutrients. The vegetation where the species was found is classified as a campo limpo de cerrado (i.e., tropical seasonal shortgrass field of cerrado [Eiten, 1983]).

Almost all the plants seen had some leaves clipped. Cattle, horses, wild animals, and insects seem responsible for the leaf predation of *Triraphis devia*. These plants are evidently fire-resistant, since all populations examined displayed signs of fire damage.

The discovery of this new species of *Triraphis* in the high elevations (ca. 1200 m) of central Brazil is exciting and puzzling: exciting because no native species of this genus has ever been reported for South America. The only known record of a species of *Triraphis* in South America is that of *T. andropogonoides*, taken in Rio de Janeiro, Brazil, in 1833 (Filgueiras & Burman, in press). That record obviously represents a case of a furtive introduction that never became successfully established. *Triraphis andropogonoides*, a native of South Africa (Gibbs Russell et al., 1990), has never been reported or collected again in Rio de Janeiro or elsewhere in Brazil or South America (Nicora & Rúgulo, 1987; Watson & Dallwitz, 1992). This is also puzzling because it is the sole known species of a predominantly African genus in the New World, with a single species in Australia.

Regarding the plant and animal relationships between Africa, America, and Australia, two different points of view developed in the last decades. Thorne (1973), Smith (1973), and other authors emphasized differences between the continents and explained present disjunct distributions as examples of long-distance dispersal between Africa and America; consequently, the relationships between these continents are, according to these authors, derived mostly from immigration, supplemented by a few subsequent transatlantic long-distance dispersal events (Gentry, 1993). On the other hand, Raven and Axelrod (1974) showed, in their synthesis of angiosperm biogeography, that there are many examples, within angiosperms, of a vicariant distribution between Africa, South America, and Australia: e.g., the Proteaceae, Restionaceae, Podocarpaceae, Winteraceae, and other groups. A similar biogeographical pattern was summarized in the Annonaceae by Schatz and Le Thomas (1993), and in the Asteraceae by Bremer (1993). Zoological evidence seems to follow the same pattern. For example, the Lung-fishes of the group Dipnoi are represented today by only three genera, one from Australia, one from Africa, and another from South America (Greenwood, 1975).

Within the Poaceae, Clifford and Simon (1981) and Simon and Jacobs (1990) emphasized that *Triraphis* is a unique chloridoid genus with a disjunct distribution between Australia and Africa. They included a number of chloridoid genera as Gondwanan elements, such as *Chloris* Swartz, *Diplachne* Beauvois, *Enneapogon* Beauvois, and *Eragrostis* Wolf. Simon (1989) stressed that major groups were well dispersed throughout the world before the final breakup of the Gondwanaland supercontinent. Consequently, the present distribution of *Triraphis*, with one species in Australia, another in South America, and six species in Africa can be explained by a vicariant event, in which the genus evolved in arid areas after the breakup of the supercontinent Gondwana; Raven and Axelrod (1974) stated that "many of the endemic families and taxa of the two continents may have survived in, or later evolved in such edaphic deserts."

The specific epithet alludes to the fact that the plants of this new species are geographically deviated (*devius, a, um*) from other species in the genus.

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